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RESEARCH PAPER

Maple Sugar Bush Management and Forest Biodiversity Conservation in Eastern Ontario, Canada

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Abstract As in many parts of the world, rural and forest-dependent communities in Ontario are struggling with a variety of economic and demographic challenges. Ontario government ministries are seeking to enhance rural sustainable development while at the same time maintaining forest habitat and preventing forest biodiversity decline. Commercial maple sugar bushes, which in Eastern Ontario are typically family owned and operated, have the potential to play an important role in biodiversity conservation and habitat protection, while at the same time contributing to sustainable development. Existing research has shown the social and economic benefits of small scale maple sugar bushes, but room remains for greater study of the environmental impacts, particularly in terms of forest biodiversity. In this study, woodlot management practices on twenty-two sugar bushes in Eastern Ontario were compared against established forest biodiversity conservation guidelines, using information obtained through detailed interviews with operators. Sugar bush operators reported the presence of many important habitats on their properties. The interview results show that many standard sugar bush management practices are consistent with biodiversity conservation principles. Operators were found to be receptive to biodiversity conservation ideals, and could enhance their contribution to the provincial government's official biodiversity strategy with additional guidance, incentives, and formal planning. The findings suggest that through sound management and planning, small scale commercial sugar bush operations generally can be made environmentally sustainable, and become important components in broader rural development strategies.

Keywords Sugar bush · Maple syrup · Biodiversity conservation · Woodlot management · Eastern Ontario

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Introduction

In recent decades, social and economic well-being in Canada's rural and forest-dependent communities has been declining, necessitating greater attention to rural sustainable development (Smit and Brklacich 1989; Troughton 1995; Bryant and Joseph 2001; Nelson 2003). In Ontario, Canada's most populous province, the share of the population living in rural areas has been falling steadily, now to only 15% (Statistics Canada 2009). Ongoing challenges faced by Ontario's remaining rural population include shortfalls in financial and human capital, declining profitability of agriculture and resource-extraction activities, and decreasing competitiveness due to rising energy costs and currency exchange rates (ORRSC 2007). Many of these stresses are similar to those in other rural areas as well. Under the 2004 *Ontario Rural Plan* the provincial government has sought to strengthen rural communities through economic, social and environmentally sustainable development (OMMAH 2004). With respect to environmental sustainability, an important component is the maintenance of biodiversity, with habitat loss and unsustainable land use having been identified as key threats in Ontario (OMNR 2005).

A commitment to rural sustainable development is especially needed in Eastern Ontario,[1] where small-scale forestry and agriculture are important components of the rural economy, and where many rural communities are struggling and in need of economic and livelihood diversification (OMAFRA 2010a; McLeman 2010; Sander-Regier et al. 2010; Eastern Ontario CFDC Network Inc 2007; OMMAH 2004). Over three-quarters of the land in the region is privately owned, and 35% of this land is forested (Bland et al. 2006), meaning that private woodlot owners have a significant influence on forest biodiversity through their management and land-use practices. Maple syrup is one forest product that is made in many private woodlots in Eastern Ontario, and for which there remains strong domestic and export markets (Chapeskie 2009). A review conducted by Whitney and Upmeyer (2004) of the limited scholarly research presently available suggested maple syrup production could potentially meet the social and economic tenets of sustainable development. However, the environmental sustainability of maple syrup production, especially its impacts on the conservation and maintenance of forest biodiversity, has yet to be fully studied.

Maple syrup has long been a Canadian icon, and holds considerable cultural significance for Canadians. When Europeans arrived in North America, Native Americans were already tapping trees and producing maple sugar—the first sugar produced in North America (Chapeskie 2009). From these origins it has become a longstanding practice for many eastern Canadian farmers to tap and collect sap from their woodlots. Canada produces about 80 percent of the world's maple syrup, with Ontario contributing approximately 4% of Canadian production (Agriculture and Agri-Food Canada 2007). In terms of quantity, the bulk of syrup sold on national and international markets comes from a relatively small number of extensive commercial operations in Quebec. The vast majority of Canadian producers remain

[1] For the purposes of this study, "Eastern Ontario" includes the counties of Lanark, Leeds and Grenville, Ottawa, Prescott and Russell, and Stormont, Dundas and Glengarry.

family-run operations, producing small quantities of syrup for personal use or local sale. There are approximately 2,600 maple syrup producers in Ontario, whose industry contributed an estimated $11.2 million to the province's economy in 2009 (Leuty 2009). In Eastern Ontario, Lanark County bills itself as the "Maple Syrup Capital of Ontario" on the basis of its 93 producers and 110,000 taps (EOMF 2006).

Although the popularly held image of a maple sugar bush is that of trees bearing metal sap collection buckets, the method developed by early Canadian settlers of European origin, most commercial maple syrup producers today use a pipeline system of plastic tubing to collect sap (Fig. 1). Each spring, spiles inserted into sugar maples (*Acer saccharum*) are connected to passing tubes, and sap is channeled by gravity or with the aid of vacuum pumps to the collection building where it is reduced to syrup through a combination of reverse osmosis and heating. Collection of sap begins when daytime temperatures rise above zero-degrees Celsius but drop back below freezing overnight, and continues for a few weeks until warming temperatures cause the sap to become stronger and less palatable.

The impacts of present-day collection systems and of broader sugar bush management practices on forest biodiversity are not well known. Since the pipeline collection system itself is relatively un-intrusive once installed, the main determinant of the relationship between forest biodiversity and commercial maple sugaring in a given forest parcel is the management practices of the operator. Concerns have been raised that some commercial producers who manage their forests with the aim of creating maple monocultures may be having effects on biodiversity, such as causing understory species richness to decline (Leniere and Houle 2006). The broad objective of the research presented here was to gain an understanding of the relationship between sugar bush management and forest biodiversity in Eastern Ontario. In particular, it aimed to generate empirical information regarding the management practices of maple sugar bush operators in the study region and to

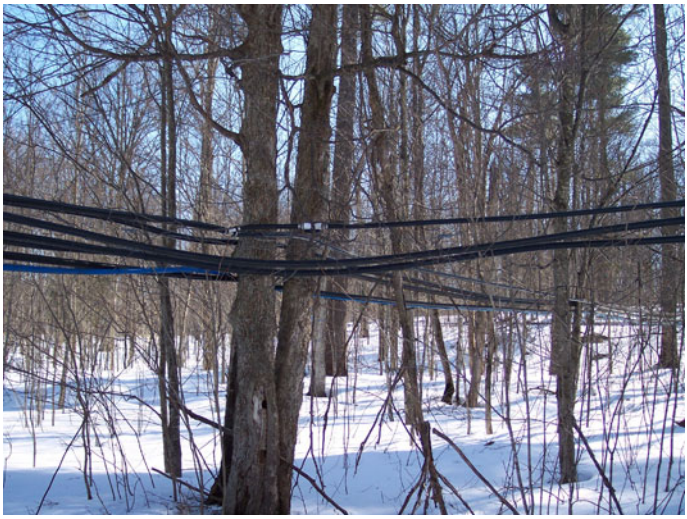

Fig. 1 Maple sap collection pipeline system. Photo credit: Authors

compare these with established management principles for forest biodiversity conservation that have specifically designed for use in this region. In doing so, the project sought to generate suggestions for woodlot operators and government policymakers alike about future opportunities for research and management decision-making. It was further intended that the study establish a simple baseline of methods and empirical findings that might be developed and modified for application in other maple producing regions. A basic operating assumption is that, if sugaring operations can be managed so that the biodiversity impacts are minimal or benign, maple syrup production could offer an opportunity for enhancing rural sustainable development in all its tenets, economic, social and environmental.

While there is very little literature on sugar bush operators and biodiversity, researchers have studied other private landowners and their attitudes and practices concerning conservation. For example, in an Indiana case study, Raymond and Olive (2008) suggested that when private landowners' beliefs and values about conservation and private property rights are understood, there is an opportunity to collaborate with them to conserve species. Fischer and Bliss (2009) found that conservation easements, habitat mitigation banking, and voluntary grass-roots initiatives appealed to both family forest owners and natural resource professionals wanting to conserve oak woodlands and savannah in Oregon. Fischer and Bliss (2006) also identified the types of policy initiatives that would encourage landowners who want to steward biodiversity but are influenced by economic and social factors that motivate them to do otherwise. Research has shown that adoption of ecosystem-based management practices among private forest owners is most likely to happen if landowners are well-informed and educated and if they self-govern the management program (Creighton et al. 2002).

The empirical study was carried out in the winter of 2010–2011, and involved 14 working sugar bushes in Lanark County, 6 in neighbouring Leeds and Grenville County, and 2 in Frontenac County (Fig. 2). The county with the most sugar bush operators and most representation in this study, Lanark County, has a population of approximately 64,000, and is approximately 3,000 square kilometres in size (Statistics Canada 2006). The northern two-thirds of Lanark County is situated on Precambrian shield, while the southern third of the county lies on a limestone plain. Fifty-seven percent of Lanark County (183,575 hectares) is forest cover, and 90% of this forested area is privately owned (Sentesy 2008). Sugar maple is a dominant tree species across the study area.

The wildlife in Lanark and vicinity has changed over time in response to human settlement in the area. Generally, wildlife habitat has become fragmented over the past two centuries through the conversion of forests to agricultural land and the development of towns and roadways. The loss of large tracts of forest interior has caused species that rely on this habitat (such as grey wolf (*Canis lupus*), eastern cougar (*Puma concolor couguar*), and wolverine (*Gulo gulo*)) to retreat northward, while those species that prefer edge and open habitats (such as white-tailed deer (*Odocoileus virginianus*) and red fox (*Vulpes vulpes*)) have increased in number (Sentesy 2008).

Sugar bush operations in the study area range in size from under 20 taps to over 20,000 taps. The average number of taps in a Lanark sugar bush is slightly under

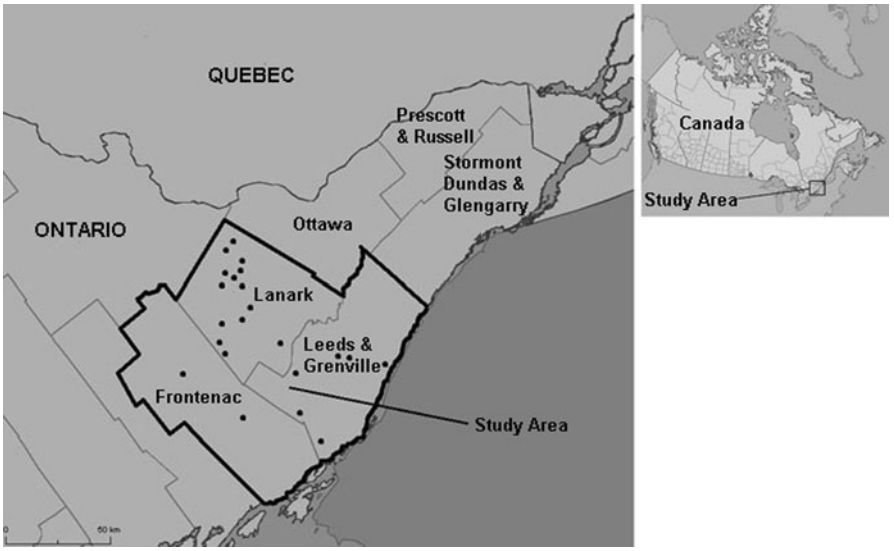

Fig. 2 Map of study area with participating sugar bush locations identified

1,200 (EOMF 2006). The smallest operators produce syrup for family use and to share with friends, while the larger operators produce syrup for farm gate, retail and bulk sales. The land area occupied by sugar bushes varies from operations that are a few hectares to ones that encompass several hundred hectares. Some sugar bushes are open to the public, and encourage tourism with pancake houses, nature trails, and/or guided tours. Many producers are members of the Ontario Maple Syrup Producers Association (OMSPA), which promotes among producers quality standards, good management practices, and effective marketing, while encouraging research and development and raising awareness about maple products among the public (OMSPA 2010).

Methods

The key aim of this project was to identify the woodlot management practices of a range of maple sugar bush operators and assess the extent to which these are consistent with forest biodiversity conservation guidelines for the region. A number of organizations provide forest management information for private forest owners in the study area, including the Eastern Ontario Model Forest (EOMF), the local land stewardship councils, the Ontario Woodlot Association (OWA), the Ontario Forestry Association (OFA), and the Forest Stewardship Council of Canada (FSC). Of these, The EOMF has developed the most detailed set of forest biodiversity conservation guidelines specific to this region (Box 1). EOMF also provides

Box 1 Eastern Ontario model forest woodlot management principles for conserving biodiversity (Adapted from Bland et al. 2006)

General management principles
Create a management plan for your woodlot
Monitor biodiversity on your property
Maintain a contiguous forest of at least 40 hectares to provide adequate habitat
Work with neighbouring landowners to reconnect fragmented habitats and to improve edge habitats between properties
Maintain a diversity of habitats
Work with contractors who understand the importance of protecting wildlife
Consult professional foresters or wildlife biologists to ensure that critical habitats for wildlife are maintained
Avoid handling or touching wildlife, eggs, or nests
Protect animal movement corridors
Specific management principles
Remove or narrow trails and roadsides that fragment wildlife habitat by planting them to trees or shrubs. Roads should occupy no more than 2% of the stand
Avoid vehicle use in the woodlot when the ground is wet and restrict ATVs and snowmobiles from sensitive areas
Keep livestock out of woodlands to reduce disturbance, retain understory vegetation and vertical complexity, protect wildlife, and avoid soil compaction
Protect habitats of rare species
Remove alien invasive plant species
Retain individuals of all tree species
Retain at least 10 conifers per hectare
For stands that have been degraded in the past, plant native species of trees and shrubs that are appropriate for site conditions
Leave brush piles as habitat for small animals
Retain rotting stumps, logs, downed trees and limbs to provide cover, escape, nesting, and feeding habitat for snakes, salamanders, toads, small mammals, and birds
Create habitat for herpetiles by putting out boards over wet leaves and letting them rot

woodlot owners with lists of biodiversity indicators and instructions for monitoring them (Hamill 2001, 2002). We chose the EOMF guidelines as a basis for constructing the research framework for this project, after first conducting a small preliminary field trial on three sugar bushes and verifying that the habitat characteristics of sugar bushes are consistent with those identified by EOMF as being significant for regional biodiversity, such as providing adequate forest interior and closed canopy, healthy undergrowth, and clean, adequately sized wet areas.

To collect a broad sample of sugar bush management data, interviews were conducted with twenty-two sugar bush operators in the region. With the assistance of an EOMF biodiversity specialist, an interview guide was developed that prioritized specific management principles to be focused on during interviews. Potential interviewees were identified through the Ontario Maple Syrup Producers Association's website, and through referrals from other sugar bush operators. Interviews were semi-structured and used a pre-designed interview guide to obtain

information about the sugar bushes' physical characteristics, their history, the management practices used by the sugar bush operators, and the operators' broader attitudes with respect to biodiversity conservation generally. At the end of the interviews, interviewees were asked for any additional thoughts they had on the subject of biodiversity and sugar bush management.

Qualitative and quantitative information gathered from interviews was entered into a specially designed spreadsheet and organized according to the type of information gathered, such as sugar bush characteristics (e.g. area, number of taps), nature of management plan (e.g. formal using guidelines from external organization, formal self-developed, informal, none), and so forth. The organization of the data in this way, which is a technique often used in grounded theory research (Bringer et al. 2004; Charmaz 2004), allowed for the easy recognition of patterns and comparison with EOMF published guidelines. The results of the data collection and interpretation now follow.

Results

Characteristics of Sugar Bushes and Habitats

Twenty-one of the twenty-two sugar bushes ranged in size from 600 to 7,000 taps; one large operation operated 20,000 taps. The area of forest being tapped varied from 4 to 150 ha. Most operators had additional forested property that was not being tapped. Most of the smaller sugar bushes provided only a part of the owner's livelihood activities. Ten were incorporated as part of a family farm, while in two cases they were linked to a campground business. Syrup production alone is typically not the sole source of income for operators; many hold a full time job elsewhere, or were retired. Six operators also reported that they sell timber that is logged from their properties. Five of those interviewed operated pancake houses as part of a diversified, maple product-based agro-tourism business.

Eighteen of the twenty-two operators self-described their sugar bushes as family operations. The rest were run independently or with business partners who were not family members. Five of the family-operated sugar bushes had been in the same family for more than 100 years. In the past, these sugar bushes were tapped to a much lesser extent than they are now. All of the operators who considered their sugar bush to be a family operation hoped to pass the business on in the family if there was interest, and this often meant that they managed their bush with long term goals in mind.

All of the interviewees were members of the Ontario Maple Syrup Producers Association. Other woodlot or landowner organizations to which participants belonged included the EOMF ($n = 6$), the OWA ($n = 6$), the local land stewardship council ($n = 4$), the United Canada Wood Co-op ($n = 1$), and the Ontario Forestry Association ($n = 1$). Two interviewees operated FSC-certified woodlots.

Operators were questioned about their attitude toward wildlife in their sugar bush. As long as it did not create a nuisance for their maple syrup operation, thirteen operators stated that they encouraged wildlife and the remainder answered that they

ignored wildlife. Specific "nuisance" animals mentioned included porcupines (*Erethizon dorsatum*), squirrels (*Sciurus sp.*), black bears (*Urus americanus*), deer (*Odocoileus virginianus*), and raccoons (*Procyon lotor*). These animals caused damage by chewing on the plastic tubing that carries the sap or chewing on the maples themselves. Eleven operators also mentioned that beavers (*Castor canadensis*) can harm the bush by cutting down or flooding maples. Thirteen operators shot or trapped at least one of these species to reduce damage.

Seven operators expressed a genuine interest in fostering high levels of biodiversity in their bush, and actively worked to maintain habitats and encourage wildlife. They stated they enjoyed having a forested property where they and their visitors could see wildlife. At least six were hunters who encouraged game animals by keeping conifer groves for deer, putting out food for wild turkeys (*Meleagris gallopavo*), building brush piles, and leaving cavity trees as habitat. Several operators expressed an interest in learning about wildlife management in the sugar bush. One operator said, "I know there's information [on wildlife management] out there and I could get it if I tried. I'm just so busy! It's something that I would be open to and that I am intrigued by."

Operators were asked to identify from an EOMF list of fifteen important wildlife habitats which ones they had on their property. The EOMF list includes the term "old growth forest." Fifteen producers had trees at least 80–100 years old on their property, but it was unclear whether these trees should be considered "old growth forest." Because of this ambiguity it was not possible to make a reliable interpretation of this data. Of the fourteen remaining important habitats identified by EOMF, every operator had at least seven on his/her property, and the average number of important habitats per sugar bush property was ten (Fig. 3).

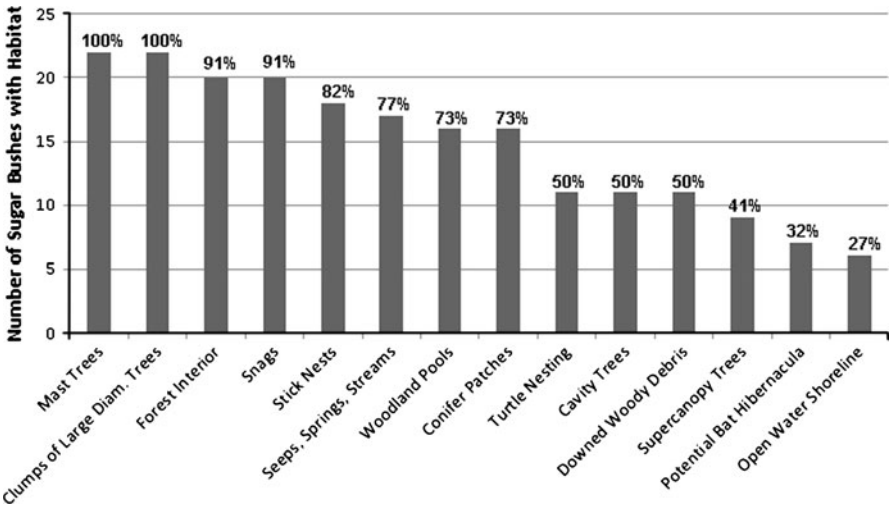

Fig. 3 Important habitats on sugar bushes as reported by operators

General Management Principles Employed by Operators

Table 1 summarizes the general management principles about which operators were interviewed and the results. As can be seen, the following general principles are being implemented in whole or in part by the majority of operators: following a management plan, monitoring biodiversity, maintaining a diversity of habitats, consulting with professional foresters or biologists, and avoiding unnecessary contact with wildlife.

For most interviewees, management planning was done on an informal basis. Only three had formal management plans, two of which were created as part of a tax incentive program. The nineteen remaining operators had informal management plans. These were not written documents, but rather mentally guarded, easily stated management objectives for different sections of their woodlot. As an example of the types of response that were common, one operator said, "We have a management plan informally. There are two main things: crown development (for syrup

Table 1 Operator adherence to general management principles for conserving biodiversity

EOMF management principle (adapted from Bland et al. 2006)	Operators following this principle	Operators partially following this principle	Operators opposing this principle	Operators neither following nor opposing this principle
Create a management plan for your woodlot	3 (14%)	19 (86%)		
Monitor biodiversity on your property		16 (73%)		6 (27%)
Maintain a contiguous forest of at least 40 hectares to provide adequate habitat	11 (50%)			11 (50%)
Work with neighbouring landowners to reconnect fragmented habitats and to improve edge habitats between properties	1 (5%)	8 (36%)		13 (59%)
Maintain a diversity of habitats	10 (45%)			12 (5 of these operators do not have a diversity of habitats) (55%)
Work with contractors who understand the importance of protecting wildlife				22 (100%)
Consult professional foresters or wildlife biologists to ensure that critical habitats for wildlife are maintained	4 (18%)	18 (82%)		
Avoid handling or touching wildlife, eggs, or nests		22 (100%)		
Protect animal movement corridors				22 (100%)

production) and keeping a certain level of tree diversity (for the public to see and because of the dangers of a monoculture). We also thin in strips." Fourteen operators claimed that wildlife conservation was something they considered as part of their planning, through such things as leaving cavity trees, mast trees, and building brush piles.

The types of information sugar bush operators could easily recall included the cover type that existed in each section of the property, the drainage directions in each section, past use of the woodlot in each section, and when and where they plan to actively manage their bush in the future. Their stated objectives included such things as promoting crown development in their maples, opening up new areas of the bush for tapping, and promoting the growth of healthy timber species. Four operators had an aerial photograph to help describe their property during the interview. One of the operators had a sketch of his property, separated into management blocks, with a prescription for each block. Another stated:

> Our management plan is informal. We leave cavity trees for wildlife. We let old trees die at their own pace, one branch at a time, so that by the time we cut them, it's usually just the bole left. Thinning practices are included. We keep all of our customers and equipment on the trails; we use the 4-wheeler as much as possible rather than the tractor. We take out wood that's of good value, and leave all the rotting stuff.

As with planning, monitoring of wildlife tends to be done informally rather than systematically. Sixteen operators mentioned noticing fluctuations in the populations of certain species such as deer, squirrels, porcupines, and fishers. The operators generally avoid handling or touching wildlife, eggs, and nests unless an animal was doing significant damage to the sugar bush operation, or if the operator was a hunter. Figure 4 below shows the animals reported to do damage in sugar bushes, and the number of operators that shot or trapped them. When operators were asked if they had any animal movement corridors in their sugar bush, all operators mentioned having many deer trails throughout, which operators did not disturb.

As recommended by EOMF, all operators had consulted a professional forester at some point, although only four of them did this specifically for questions relating to wildlife or biodiversity. One of these operators had his understory plants identified. He stated that as a result of this, "Now I'm more aware of these plants and am careful not to run them over or harm them." Another had help creating a brochure for his nature trail. One operator was himself a fish and wildlife technician. Thirteen operators had their trees marked for thinning by professional foresters, created their management plan with a forester, or spoke with a forester about specific problems such as insect outbreaks. Three operators mentioned that foresters had marked trees for timber extraction purposes, but they did not necessarily follow all the marker's instructions when doing so would conflict with the sugar bush operation.

The general principles of maintaining a contiguous forest of at least 40 ha and maintaining a diversity of habitats are being followed by 45–50% of interviewees. Only half the operators had a sugar bush that was part of contiguous woodland of at least 40 ha. Ten of these operators owned the entire forty hectares or more, while the other operator's sugar bush connected to adjacent forested properties to make up

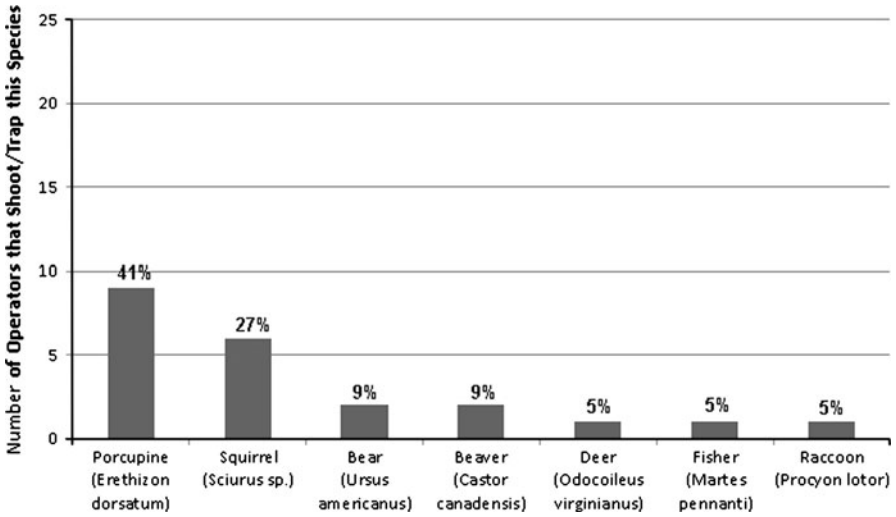

Fig. 4 Nuisance animals shot or trapped on sugar bushes as reported by operators

the 40 ha. Five operators reported having a relatively homogeneous hardwood forest on their property, while the others reported having a variety of other habitats such as swamps, marshes, wetlands, bramble areas, high rocky areas, conifer groves, gravel and sand pits, open water shoreline, and ponds. As an example, one operator described the diversity of habitats on his property when he stated, "The bush is swampy in some areas, but there's no tapping there. About 60% is low and wet. Other parts of the property are high and wet with white cedar, white pine, tamarack, and white birch." Ten operators stated they were pleased to have diverse habitats on their properties and were careful not to harm them, while the others were indifferent to having the diversity of habitats but took no actions to alter or remove them.

Only one general principle was not being followed by most interviewees, that being to work with neighbours to reconnect fragmented habitats and improve edge habitats. Those sugar bushes that were part of a larger farm often had crops growing at the edges, or were fenced at the edges to prevent livestock from entering.

Although EOMF suggests woodlot owners hire contractors who understand the importance of protecting wildlife, all of the interviewees reported they generally did their own work, and tried to minimize damage to their trees.

Specific Management Principles Employed by Operators

Table 2 summarizes the specific EOMF principles about which operators were questioned and the results. Of these, the majority of operators were implementing the following principles in whole or in part: keeping trails to a minimum, restricting vehicle use in wet or sensitive areas, retaining a variety of tree species (including a minimum of conifers), and leaving brush piles and downed trees for habitat. The actual execution of these practices varied considerably between sugar bushes.

Table 2 Operator adherence to EOMF specific management principles for conserving biodiversity

EOMF management principle (adapted from Bland et al. 2006)	Operators following this principle	Operators partially following this principle	Operators opposing this principle	Operators neither following nor opposing this principle
Remove or narrow trails and roadsides that fragment wildlife habitat by planting them to trees or shrubs. Roads should occupy no more than 2% of the stand	1 (5%)	21 (95%)		
Avoid vehicle use in the woodlot when the ground is wet and restrict ATVs and snowmobiles from sensitive areas	5 (23%)	17 (77%)		
Keep livestock out of woodlands to reduce disturbance, retain understory vegetation and vertical complexity, protect wildlife, and avoid soil compaction	8 (36%)		2 (9%)	12 operators do not have livestock (55%)
Protect habitats of rare species		2 (9%)		20 (91%)
Remove alien invasive plant species		5 (23%)	2 (9%)	15 (68%)
Retain individuals of all tree species	7 (32%)	13 (59%)	2 (9%)	
Retain at least 10 conifers per hectare		22 (100%)		
For stands that have been degraded in the past, plant native species of trees and shrubs that are appropriate for site conditions	4 (18%)			18 (82%)
Leave brush piles as habitat for small animals	14 (64%)		8 (36%)	
Retain rotting stumps, logs, downed trees and limbs to provide cover, escape, nesting, and feeding habitat for snakes, salamanders, toads, small mammals, and birds	7 (32%)	14 (64%)	1 (5%)	
Create habitat for herpetiles by putting out boards over wet leaves and letting them rot				22 (100%)

Most operators had relatively little of their acreage in trails, but the density and width of trails varied from none at all to several large trails wide enough for a tractor. All but one operator reported using some sort of vehicle in his sugar bush, but most used these primarily in winter when the ground is frozen and/or in the sugaring season.

In terms of maintaining tree diversity, twenty sugar bushes supported tree species other than sugar maples, with at least thirty-one different species represented (Box 2). Twelve operators actively supported a variety of tree species, the others simply accepted the mix of species for what it was. Two of the smaller operators, where sugaring is only part of a larger farm enterprise, had selectively cut to achieve maple

Box 2 Tree species present on sugar bushes participating in this study

Sugar maple (*Acer saccharum*)
Black maple (*Acer nigrum*)
Silver maple (*Acer saccharinum*)
Red maple (*Acer rubrum*)
Striped maple (*Acer pensylvanicum*)
Hickory (*Carya sp.*)
Butternut (*Juglans cinerea*)
Black walnut (*Juglans nigra*)
Red oak (*Quercus rubra*)
White oak (*Quercus alba*)
White ash (*Fraxinus Americana)*
Black ash (*Fraxinus nigra)*
Elm (*Ulmus sp.*)
American beech (*Fagus grandifolia)*
Black cherry (*Prunus serotina)*
Basswood (*Tilia Americana)*
Ironwood (*Ostrya virginiana)*
Tulip tree (*Liriodendron tulipifera*)
Poplar (*Populus sp.*)
Yellow birch (*Betula alleghaniensis)*
White birch (*Betula papyrifera*)
Scots pine (*Pinus sylvestris*)
Jack pine (*Pinus banksiana*)
Eastern white pine (*Pinus strobus*)
Red pine (*Pinus resinosa*)
Red spruce (*Picea rubens*)
White spruce (*Picea glauca*)
Eastern white cedar (*Thuja occidentalis*)
Balsam fir (*Abies balsamea*)
Eastern hemlock (*Tsuga canadensis*)
Tamarack (*Larix laricina*)

monocultures, although they did maintain a buffer of conifers around the edges. When thinning trees, sugar bush operators gave preference to healthy sugar maples and took out other species for various reasons, including canopy thinning, firewood or lumber harvesting, or to reduce pests or disease. The following quotes illustrate some of the difference in practices among operators:

> I cut ironwood, cherry, basswood, and beech (unless they are really nice specimens). And I keep maple.

> I cut out everything but maples. I like to leave a wide area of empty space around the maples to let them grow. The only other species I leave are the pines as a wind buffer at the edge.

> I thin out the cedar, but try to leave a little bit of everything.

Most operators did not know how many conifers they had per hectare, but all of the operators reported having conifers in or near their sugar bush. For thirteen operators, conifers were simply left to inhabit areas not suitable for maples. Three operators purposely kept conifers as wind buffers, deer habitat, or to draw squirrels away from pipeline areas. Four operators cut conifers out of the working parts of the sugar bush to prevent shading young maples and their pipeline, and to eliminate squirrel habitat for squirrels.

Fourteen of the twenty-two operators created habitat by leaving brush piles when thinning their sugar bush. The other operators did not pile brush because this is time-consuming and because it rots faster when not piled. Seven operators left all downed woody debris in their bush unless it posed a safety hazard. One operator took everything out to keep the bush clear and accessible. The rest of the operators took out some woody debris, usually what was good for firewood, and left everything else to rot.

Only ten of the twenty-two operators kept livestock. Eight of these kept their livestock fenced out of the sugar bush. Of the other two, one said that the cattle were not fenced out of the bush, but usually did not go in because they had better pasture elsewhere. The other operator planned to start keeping the cattle out of the bush because of the lack of regeneration from the cattle grazing the undergrowth.

Adherence to other specific EOMF management principles varied considerably from one operation to another. Species listed on Ontario's Species at Risk list (OMNR 2011) were reported by a number of operators. Two operators protected the areas where American Ginseng (*Panax quinquefolius*) grows; one of these operators actively planted ginseng. Operators did not specifically protect the habitats of other rare species, although two had actively planted butternut trees (*Juglans cinerea*) to help re-establish this species. Many of the sugar bushes also hosted invasive species (Fig. 6), which the EOMF encourages operators to eradicate. Four operators cut

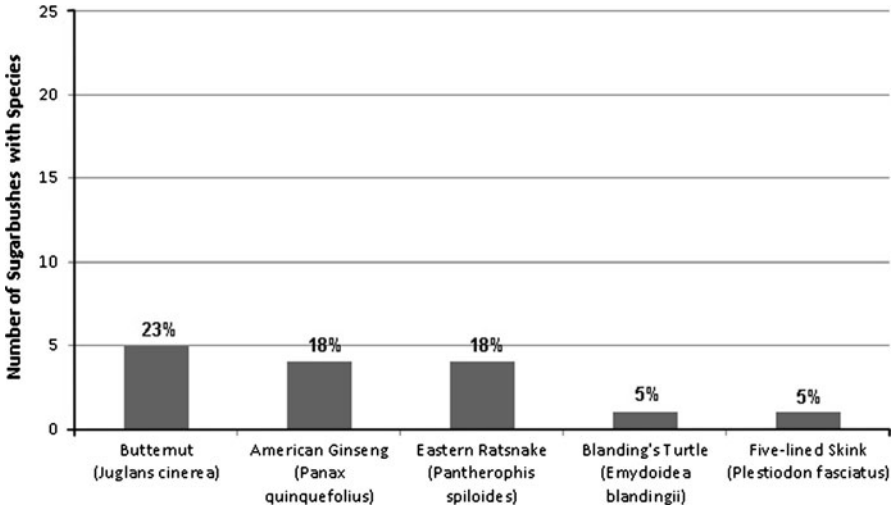

Fig. 5 Rare species on sugar bushes as reported by operators

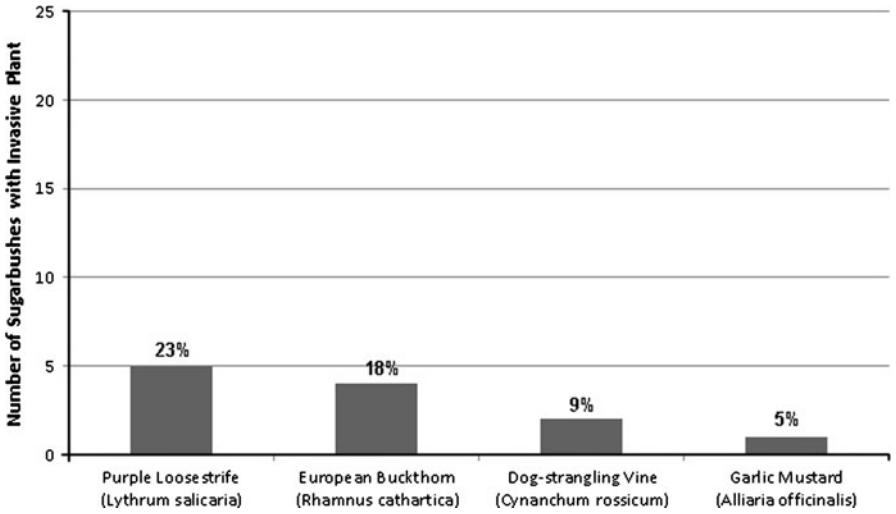

Fig. 6 Invasive plants on sugar bushes as reported by operators

buckthorn; the other invasive plants were typically left alone. One operator mentioned a failed attempt to get rid of dog-strangling vine. Nine operators actively remove prickly ash (*Xanthoxylum americanum*), but this weed species is native to Ontario.

All operators mentioned woodlots having been damaged by a severe ice storm in 1998, with some mentioning past damage from livestock grazing in the bush ($n = 6$), droughts ($n = 2$), windstorms ($n = 2$), and gypsy moth (*Lymantria dispar*) ($n = 1$). While EOMF encourages active replanting of native species, operators noted that sugar maples regenerate naturally quite successfully. Four operators helped the process along by planting new maples; other operators planted species other than maples. Two planted butternuts in partnership with programs to help re-establish this endangered tree species. One operator planted walnuts. Three operators planted conifers; one planted mainly white spruce and another planted a few hundred red and white pines, jack pines, and white spruce on his property because they had been cut out in the past and were not regenerating naturally.

As well as questions relating directly to management principles, operators were also asked for any other thoughts they had on the subject of biodiversity and sugar bush management. Operators mentioned both positive and negative influences of sugar bush management on biodiversity. Positive influences included the maintenance of contiguous forest habitat that might be lost through other land uses, increased benefits for species that rely on maples, protection of hardwoods that are being heavily cut in other areas, and the creation of food sources and cover habitat that result from thinning practices. Negative influences reported by operators included disturbance of wildlife by human presence in the bush, removal of den trees and nut trees to discourage nuisance animals, aggressive promotion of maples that results in monoculture, loss of species richness due to the promotion of maples

and loss of other tree species, and the restricted movement of larger mammals due to pipelines.

Discussion and Recommendations

Through this comparison of sugar bush operators' management practices with established best practices for woodlot management for forest biodiversity conservation, a number of insights emerge that are relevant to gauging the environmental sustainability of Eastern Ontario's maple syrup industry. The results indicate that it is indeed possible to manage a sugar bush in ways that conserve biodiversity, and many sugar bush operators are already doing this in many respects, even in the absence of formal biodiversity management plans. This suggests there are a number of opportunities for enhancing sugar bush operators' roles as biodiversity stewards, and for strengthening their potential to contribute to rural sustainable development.

Of twenty general and specific management principles, thirteen were being followed or partially followed by the majority of operators to whom they apply. Operators do so for a variety of motives. Some principles are followed because they are inherently beneficial to the sugar bush operation and they make good business sense. For example, sugar bush operators keep livestock out of their sugar bushes to avoid soil compaction, which makes it harder for trees to grow, and to prevent young maples from being grazed. For similar reasons, human movement through the bush is minimized. Operators build brush piles because it makes it easier to move through sections of the bush where they need periodic access. While these practices happen to be good for biodiversity, they are undertaken primarily because they make good business sense.

Other biodiversity principles are respected simply because the operator would have to do something deliberate to "break" the principle, and there is no logical reason to do so. For example, many operations have a naturally occurring diversity of habitats. There is no logical reason for the sugar bush operator to actively fragment the forest or destroy habitats; these are inherent properties of a successful land use system. Similarly, by keeping disturbance and fragmentation to a minimum, operators ignore or passively observe wildlife in their bush, and so comply with principles that warn against touching or handling wildlife, eggs, or nests. They would have to go out of their way to violate this principle, and there is little reason for them to do so beyond dealing with nuisance animals. None of the nuisance animals mentioned by operators are scarce in the study region or appear on protected species lists.

Operators could be encouraged to apply more thoroughly some of the principles which they are currently only partially following. Although nineteen of twenty-two operators do not have a formal management plan for their woodlot, their informal management plans intuitively include many of the biodiversity management principles recommended by the EOMF. The particular mix of principles employed varies from one operation to the next, but interestingly, only five of the management principles are actively opposed, and these only by a relatively small number of operators. This implies that in Eastern Ontario there is not a strong opposition to

managing for biodiversity, and it may therefore be possible to motivate operators to adopt the full suite of principles, or close to it. This suggests it may be worthwhile considering initiatives to encourage, assist, and train sugar bush operators in developing formal management plans which would help them manage for biodiversity. Doing so would entail familiarizing operators with biodiversity conservation principles, assisting them in identifying important biodiversity features on their properties, and providing tools and incentives for creating and maintaining such plans. Professional foresters already employed by the Ministry of Natural Resources could aid sugar bush operators in creating management plans for their woodlots.

The need for incentives seems particularly important. Of the three operators that have a formal, written management plan for their sugar bush, two did so because of tax incentives under the Ontario Ministry of Natural Resources (OMNR) Managed Forest Tax Incentive Program (MFTIP), which reduces their property taxes by 75% if they have an approved management plan. However, MFTIP provides little motivation for most sugar bush operators to create management plans for their woodlots because of competing benefits under the provincial tax code. The nineteen operators without formal plans do not participate in the MFTIP program because their operations fall into the Farm Property Tax Class, where property taxes are already reduced by 75%. To fall into this tax class, the property must be classified as farmland and generate at least $7,000 annually (OMAFRA 2010b). Since most of the sugar bushes in this study meet these requirements, or are part of a larger farm property that meets these requirements, the producers avoid the bother of creating a management plan for their woodlot by going with the farm property tax break instead of MFTIP. Operators who already receive a tax break might be motivated to create a management plan with a fee-for-service incentive. In a fee-for-service scenario, operators with a formally managed woodlot could receive payments for maintaining environmental services from which many other people reap benefits. This kind of incentive has been successful with farmers and livestock operators participating in the Alternative Land Use Services program in other regions of Ontario (Norfolk ALUS 2010).

In the case of management principles where adherence is mixed, we observed no obvious patterns in terms of the size or type of sugar bush; rather, these seemed to depend on the concerns and priorities of the individual operators. In such cases, education and outreach might increase their adoption of particular principles. For instance, if operators do not know the ecological reasons and methods for protecting habitats of rare species or improving edge habitats, they are unlikely to take the time and effort to do so.

One area where nearly all operators could improve is in systematically monitoring the biodiversity on their sugar bushes. Without standardized and systematic monitoring, it is difficult to gauge changes in biodiversity over time, or assess the progress and success of operators in maintaining or improving biodiversity (Bland et al. 2006). Some EOMF monitoring procedures require time, skills, and/or additional effort to implement, which may be a barrier to their uptake. One operator suggested that a simple one-page tally sheet that is easy and clear to use for observations in the bush would be a good idea. Many of the operators who

participated in this study were generally interested in supporting biodiversity in their sugar bushes and would likely take advantage of programs that make active monitoring worthwhile. Operators who ran a large farm tended to be less interested in managing for biodiversity, but there were exceptions to this. The information produced from biodiversity monitoring might also be used to educate and attract wildlife enthusiasts to those sugar bushes that are open to the public.

Of the five EOMF management principles where we encountered a small percentage of operators acting directly opposite, we again see room for outreach. For example, one operator who currently allows livestock in his bush recognizes the importance of keeping them out, and plans to start doing so. This demonstrates that once the underlying basis for a principle is recognized by an operator, they may adopt it. One operator illustrated this idea when he said, "It would be good to find out what works for sugar bushes and wildlife, and promote it. Sell it in publications: What's in it for us? Why should people build things for wildlife?"

From our results, we suggest a number of general findings may apply more broadly to other sugar producing areas. First, managing for biodiversity conservation needs to be considered within the context of, and not separate from, the syrup production process as a whole. Operators have a variety of land management responsibilities, and for many of them, the sugar bush is only one part of their larger livelihood activities. Biodiversity conservation activities that divert their labour or resources from other parts of their livelihood system are not likely to receive great buy-in unless operators are required or incented to do so. Research elsewhere suggests that incentives are more effective than restrictions and regulations in getting private landowners to conserve biodiversity on their properties (Vanclay 2007), a sentiment mirrored in our study. One operator suggested that "a good idea would be government programs that reward good behavior like having high tree diversity. Right now there is no incentive to do anything like that—it makes no difference if you have all maples, or high diversity." When asked about formal monitoring, some operators expressed concern that government officials might find species at risk on their properties and consequently impose restrictions on their operations. Such concerns are not unique to sugar bush operators, but are reflective of a larger, growing trend in rural Ontario of suspicion and resentment of government land use regulations that are perceived as becoming onerous (OLA 2010).

Engaging private landowners in habitat protection is an explicit aim of Ontario's Biodiversity Strategy (OMNR 2005), as it is in many other jurisdictions (Government of Saskatchewan N.d.; Nova Scotia Department of Natural Resources 2011). This study suggests sugar bush operators could make receptive and effective partners. However, it is also clear from the study that operators could benefit from an increased awareness of the broad aims of such strategies. This might be done through producer organizations such as Ontario's Maple Syrup Producers Association (OMSPA).

The challenge, therefore, is to get into place the mechanisms necessary to transmit these established biodiversity conservation principles to individual operators and encourage their adoption in an era of reduced government resources. For example, one reason for the gap between knowledge and uptake may be the

longer-term legacy of cutbacks to Ontario MNR-provided forestry services made during the 1990s. Operators mentioned that in the past, MNR had staff foresters landowners could consult. Operators would generally like to see such services reinstated, although ideally these services would include more foresters who are familiar with the particular dynamics of a sugar bush (we noted earlier that a number of operators had had mixed experience with the prescriptions of foresters lacking such knowledge). An alternative option to recreating government forester positions could be building greater capacity among existing organizations that promote stewardship on private woodlots (e.g. OWA, EOMF, FSC), to which many sugar bush operators already belong. Yet another opportunity is to borrow good ideas from other land use incentive programs, such as the Alternative Land Use Services (ALUS) program, a fee-for-service program that operates in parts of Alberta, Manitoba and Norfolk County, Ontario, to incent, train and reward farmers and ranchers to restore native habitat on lands where it has been severely diminished (Norfolk ALUS 2010).

Much more research remains to be done on the questions explored in our study. All participants in our study are members of the Ontario Maple Syrup Producers Association who willingly volunteered to participate. We do not know the attitudes of operators who declined to participate, or who are not members of OMSPA, Lanark County happens to be one of the larger syrup producing regions in Ontario, but pales in scale with operations in Quebec. Whether our findings are replicable and relevant in smaller Ontario regions or in other jurisdictions with other land management regulations remains to be seen.

This study looked at the management practices employed by sugar bush operators and their potential influence on biodiversity in the sugar bush, and would benefit from complementary research that measures biodiversity on sugar bushes directly. The species and habitats found on sugar bushes could be directly compared with those found in unmanaged forests and in forests managed for other uses, an initiative that was beyond the scope of the present study. Doing so, and communicating the results through producer associations, could provide sugar bush operators a clearer idea of what important species and biodiversity features they could work to preserve. As well, further social science research would be useful to determine what kinds of programs, incentives and additional information might best encourage sugar bush operators to more actively conserve biodiversity on their properties and generate more rigorous management plans.

Conclusion

Maple syrup production is socially and economically sustainable, and it is widely believed that sales of maple products will continue to grow in the future (Whitney and Upmeyer 2004). In Eastern Ontario, as in many other maple syrup producing regions, sugar bushes are family operations that provide livelihoods and incomes in rural areas that are often struggling economically. Like governments elsewhere, the Ontario government is actively seeking sustainable ways to enhance the wellbeing of rural communities while at the same time promoting the protection of ecological

goods and services, including biodiversity. This study suggests that, when practiced well, there is an inherent environmental sustainability in small scale sugar bush operations. Those who work in these enterprises are in many instances unconsciously practicing good biodiversity conservation principles as they go about their day-to-day operations. With relatively little investment, institutions could be working much more closely with sugar bush operators to enhance and expand the operators' stewardship of the forest. Consequently, we suggest that small scale maple sugar bushes can make an important contribution to rural sustainable development in Eastern Ontario, and likely in other maple producing regions as well. We recommend that they be the target of increased research and investment in the future.

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